

International Earth Science Constellation
Mission Operations Working Group
December 4-6, 2018
Aqua/Aura Inclination Adjust Maneuver Series
Spring 2019 Planning
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Agenda

- 2019 Drag Make-Up (DMU) Maneuver Strategy
- Recap of Spring 2018 MOWG
- Summer 2018 Risk Mitigation Maneuver (RMM) and Inclination Adjust Maneuvers (IAM)
- Spring 2019 IAM Series Plan
 - Aura IAMs on Wheels
 - Aqua and Aura Maneuver Schedule
 - Predicted Aqua and Aura Maneuver Performance
- Aqua/Aura 2019-2020 Mean Local Time (MLT) Predictions
- 2019 IAM Campaign Summary

Drag Make-up Maneuver Strategy

- For the remainder of 2018 and all of 2019, Aqua and Aura will execute DMU maneuvers at the argument of latitude that best maintains frozen orbit requirements
- Since transitioning to no-slew DMU maneuvers, most maneuvers were performed at alternating pole locations
- With the current low-drag environment, both missions are using a modified targeting scheme:
 - A four-week DMU cadence is being utilized for maneuver planning
 - GTE controlled near the top quarter of the control box
 - This allows room to execute Risk Mitigation Maneuvers (RMM) and remain in the control box
- RMM locations are dictated by conjunction timing and geometry

Recap of Spring 2018 MOWG

- At the Spring 2018 MOWG, the overall performance degradation for Aqua and Aura was presented
 - Aqua total 2018 series performance: 2.53% COLD
 - Aura total 2018 series performance: 1.56% COLD
- The preliminary Spring 2019 IAM series plan was presented
 - Aqua: 6 IAMs
 - Aura: 6 IAMs
 - Burn order: Aura before Aqua
 - All IAMs would be performed with thruster-based slews
- Aqua was predicted to be outside the “mission goal” MLT constraint (13:35:00 – 13:36:30) during the 2019 IAM series

Summer 2018 RMM and IAM

- On July 12, 2018, Aqua executed a RMM in response to a high interest event, with an achieved delta-V of 6.95 cm/s and an achieved delta semi-major axis (SMA) of 126.3 m
- In order to maintain GTE (Ground-Track Error) requirements, Aqua executed an IAM on August 2, 2018 with a large negative yaw angle
- This provided enough negative delta-SMA to keep Aqua within its GTE science requirement box
- To maintain MLT phasing with Aqua, Aura also executed an IAM on August 1, 2018
- As a result, the 2019 series plans presented at the June 2018 MOWG are no longer valid
- Aqua will no longer exit its “mission goal” MLT constraint in 2019
- Aqua and Aura will now perform 4 IAMs each in 2019

Aqua Spring 2019 IAM Campaign Planning

- The updated Aqua Spring 2019 IAM plan consists of four inclination maneuvers
- Burn duration: 560.0 seconds
- Aqua's predicted ideal burn date occurs around March 23, 2019
- Proposed plan has three maneuvers occurring before the ideal burn date and one after
 - March 7, 2019 (IAM #62)
 - March 14, 2019 (IAM #63)
 - March 22, 2019 (IAM #64) – performed on Friday due to equinox activity on March 20
 - March 28, 2019 (IAM #65)

Note: Performing maneuvers off of the ideal date slightly decreases burn efficiency

Aura Spring 2019 IAM Campaign Planning – IAMs on Wheels

- Aura's 2019 IAM series is expected to be executed using its reaction wheel assembly (RWA) to slew out to the burn attitude and slew back to nominal pointing
- These slews will not contribute to the overall inclination change or contribute to the SMA changes
- The maneuver durations and slew angles have been adjusted to achieve the desired ΔI (for the phasing relative to Aqua) and altitude change (to maintain the ground track)

Aura Spring 2019 IAM Campaign Planning

- The Aura Spring 2019 IAM plan consists of four inclination maneuvers with slews on wheels
- Burn duration: 385.0 seconds
- Aura's predicted ideal burn date occurs around March 28, 2019
- Proposed plan has all maneuvers occurring before the ideal burn date
 - March 6, 2019 (IAM #59)
 - March 13, 2019 (IAM #60)
 - March 21, 2019 (IAM #61) – performed on Thursday due to equinox activity on March 20
 - March 27, 2019 (IAM #62)

Note: Performing maneuvers off of the ideal date slightly decreases burn efficiency

Proposed Aqua/Aura 2019 Maneuver Schedule

Aqua/Aura 2019 Inclination Maneuver Series Schedule

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
February 24	25	26	27	28	March 1	2
3	4	5	6 Aura IAM #59	7 Aqua IAM #62	8	9
10	11	12	13 Aura IAM #60	14 Aqua IAM #63	15	16
17	18	19	20*	21 Aura IAM #61	22 Aqua IAM #64	23**
24	25	26	27 Aura IAM #62	28 Aqua IAM #65	29	30
31	April 1	2	3 Aura Backup	4 Aqua Backup	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20

*Spring Equinox on March 20

**Aqua Ideal Date on March 23

2019 Predicted Maneuver Performance*

AQUA

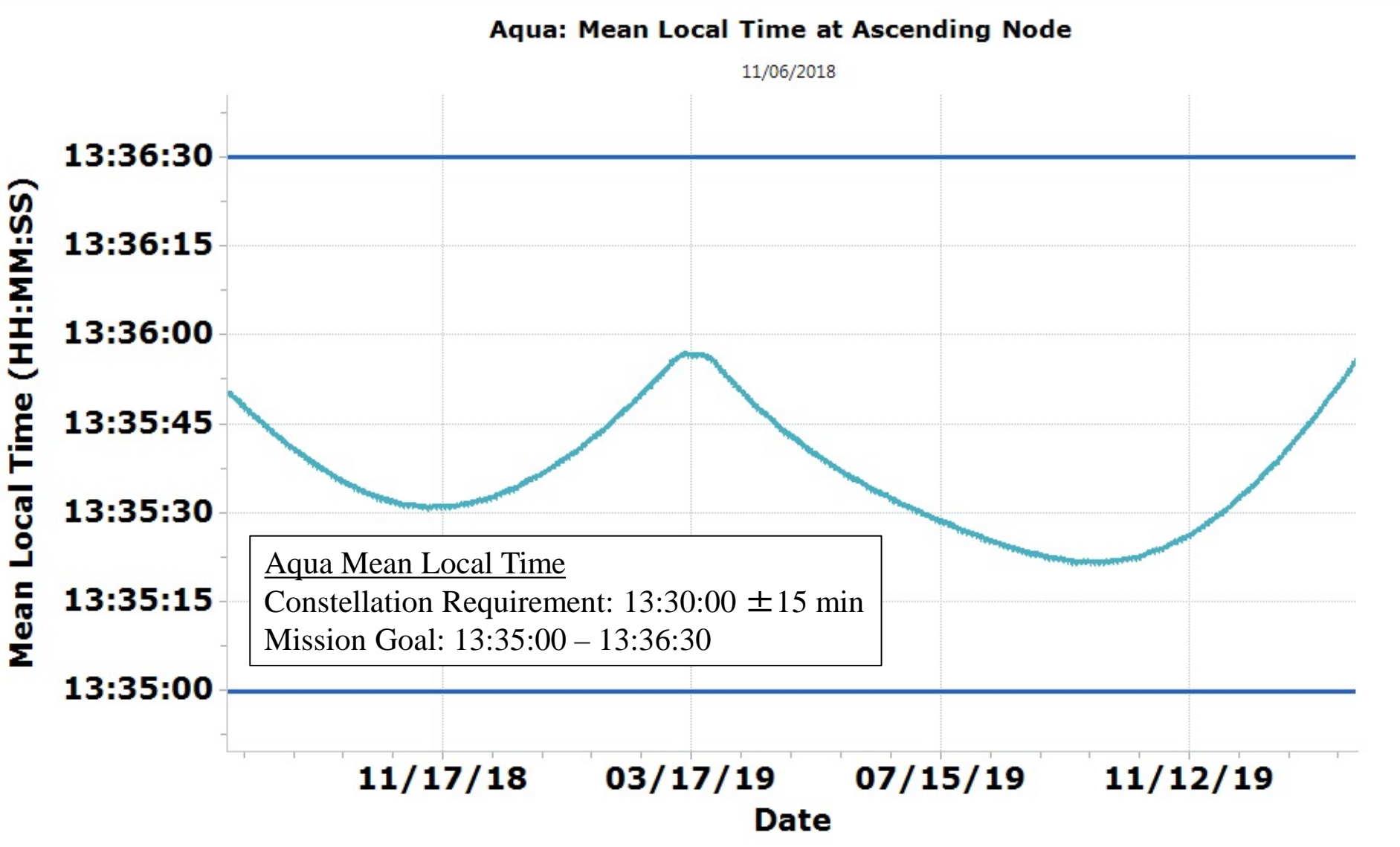
IAM #	Date	Target Yaw Angle (deg)	Burn Duration (sec)	Delta-V (m/sec)	Delta-SMA (m)	Delta-Inc (deg)	Delta-RAAN (deg)
62	March 7, 2019	-88.56	560.00	1.24109	-13.64	-0.00771	0.00094
63	March 14, 2019	-88.51	560.00	1.22926	-4.83	-0.00766	0.00053
64	March 22, 2019	-88.41	560.00	1.21445	8.31	-0.00757	0.00005
65	March 28, 2019	-88.48	560.00	1.20557	8.87	-0.00749	-0.00030
					Total Delta-Inc (deg)	-0.03043	0.00122

AURA

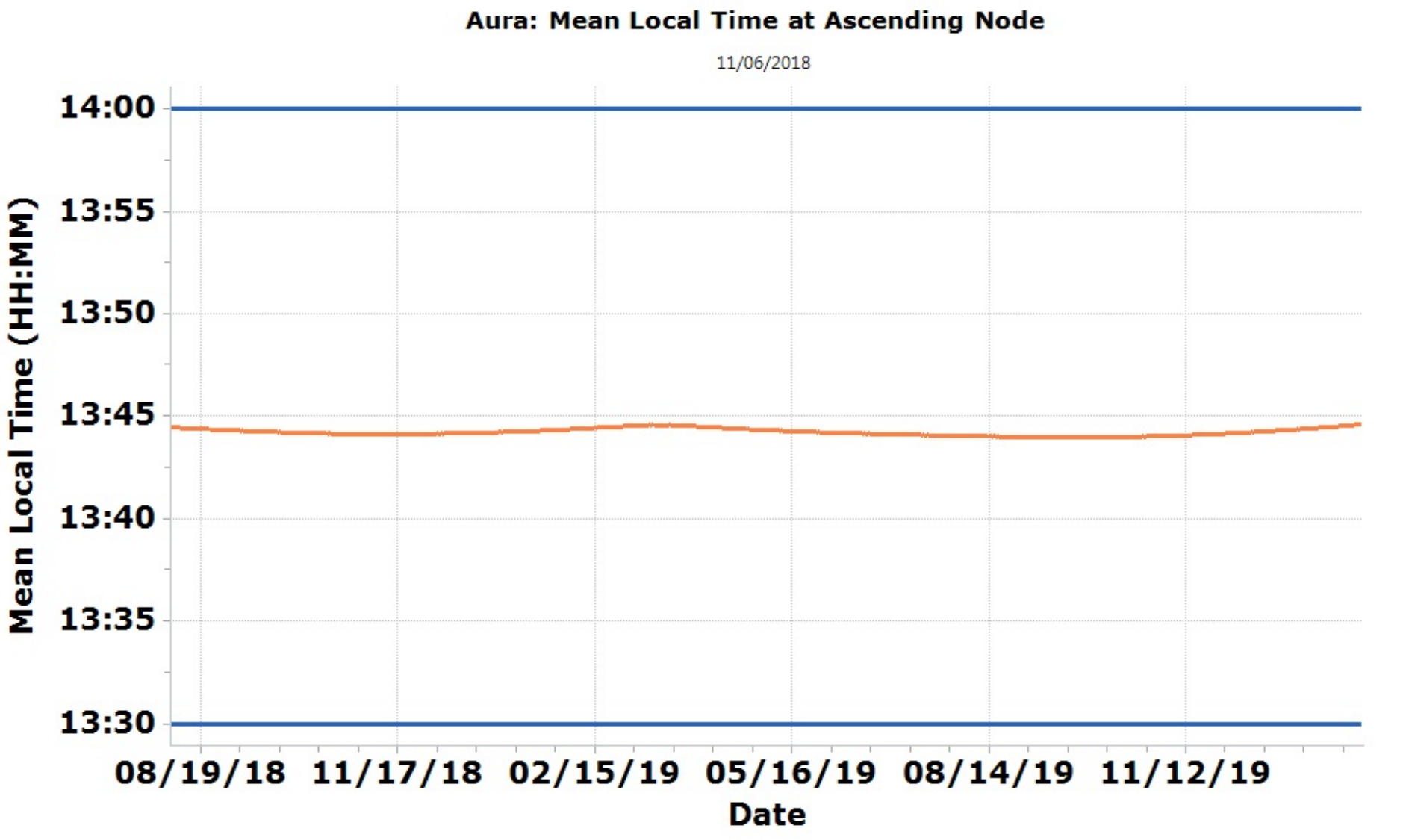
IAM #	Date	Target Yaw Angle (deg)	Burn Duration (sec)	Delta-V (m/sec)	Delta-SMA (m)	Delta-Inc (deg)	Delta-RAAN (deg)
59	March 6, 2019	-75.94	385.00	1.06718	0.58	-0.00810	-0.00001
60	March 13, 2019	-75.94	385.00	1.06389	0.59	-0.00807	-0.00001
61	March 21, 2019	-75.94	385.00	1.06065	0.52	-0.00805	-0.00001
62	March 27, 2019	-75.94	385.00	1.05744	0.49	-0.00802	-0.00001
					Total Delta-Inc (deg)	-0.03224	-0.00004

* Source: Aqua and Aura Lifetime Analyses, November 2018, Spencer Boone and Elena Trenholme

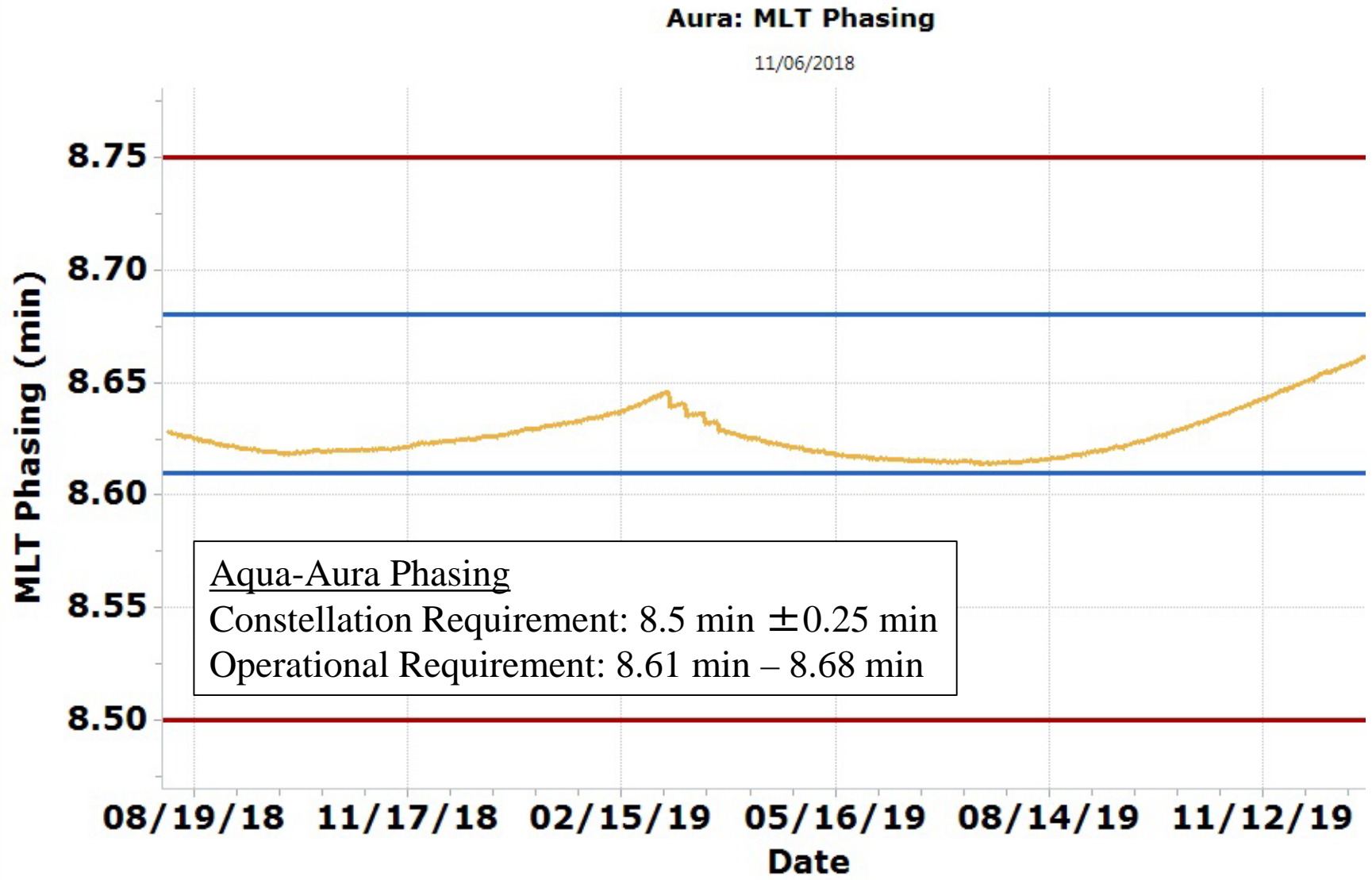
Aqua Predicted Pre- and Post-2019 IAM MLT



Aura Predicted Pre- and Post-2019 IAM MLT



Aqua-Aura Lifetime MLT Phasing Based on Planned IAM Strategy



Aqua/Aura Spring 2019 Series Planning Summary

- The Aqua MLT box of 13:35:00 - 13:36:30 and Aqua-Aura MLT relative phasing box of 8.61 - 8.68 minutes in 2019 will be maintained
- Aqua and Aura executed one IAM each in August 2018; as a result, the number of maneuvers in the 2019 series was reduced
- The Aqua and Aura Spring 2019 IAM series will consist of four inclination maneuvers for each mission
- Aura is expected to perform all 2019 IAM slews on wheels
- Aqua burn duration: 560.0 seconds
- Aura burn duration: 385.0 seconds
- Planned Aqua ΔI : -0.03043°